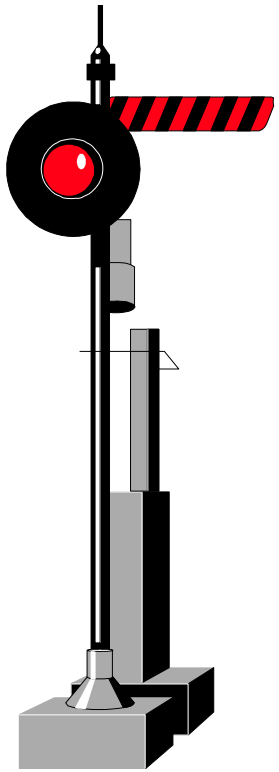
RAILER SMS

Track Structure Condition Index (TSCI)

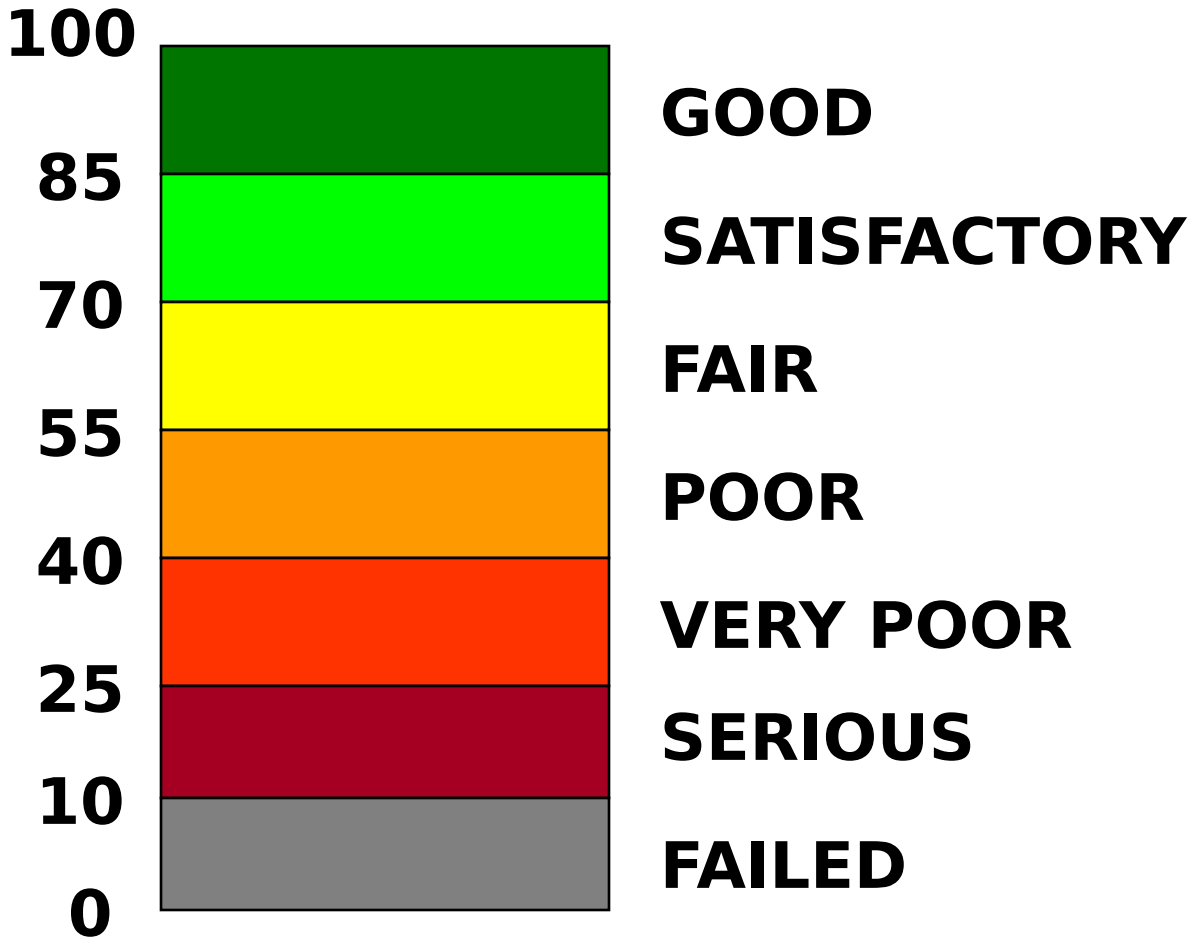
Version 6.0.0

TSCI Significance

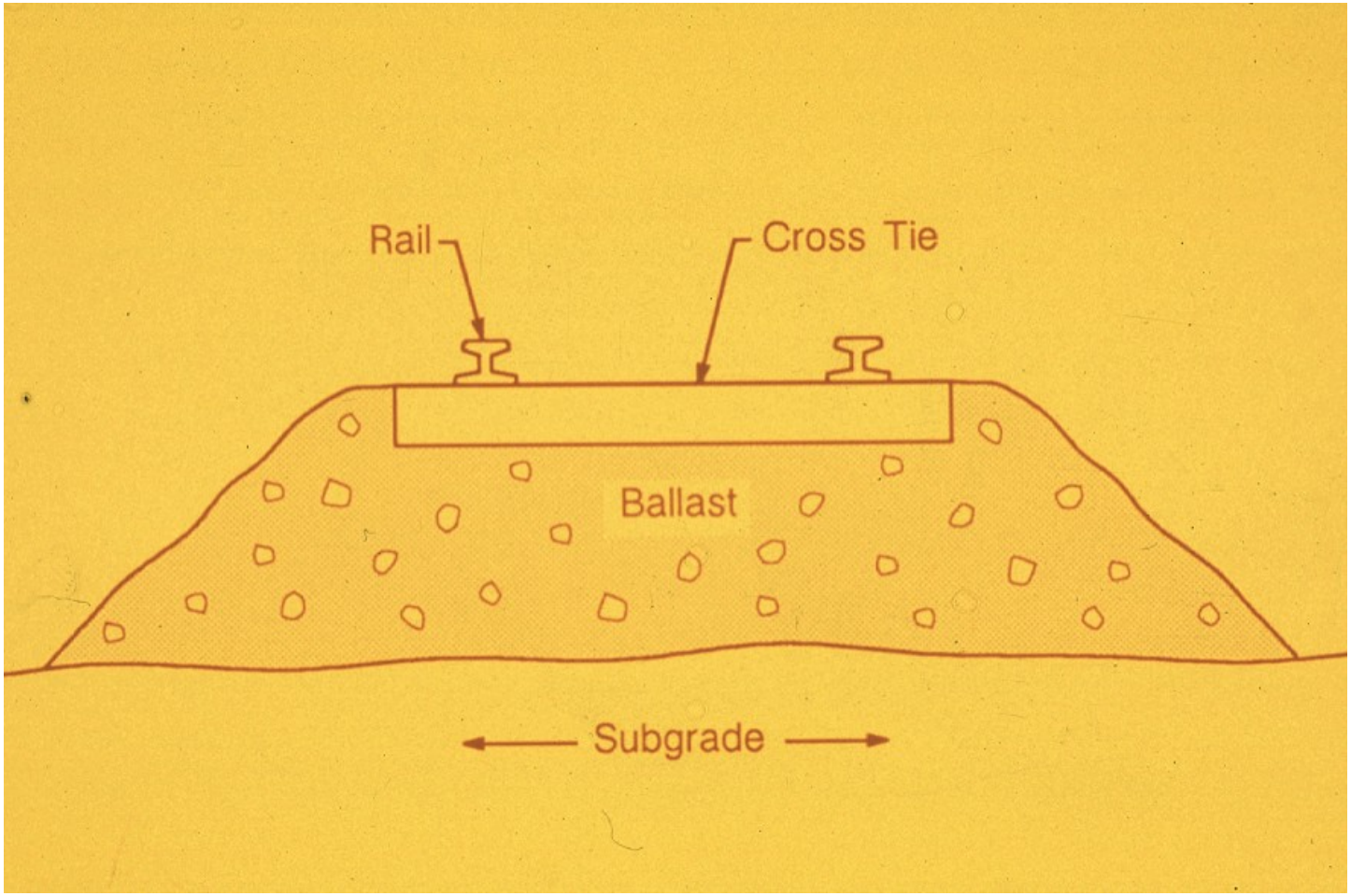


- Based on routine visual track inspections.
- Reflects the track segment’s current ability to support routine traffic.
- Indicates the maintenance and repair (M&R) requirements for restoring or sustaining the track to an acceptable condition.

TSCI Scale


100
85
70
55
40
25
10
0
GOOD
SATISFACTORY
FAIR
POOR
VERY POOR
SERIOUS
FAILED

Component Group Interaction



TSCI Relationship to Component Groups

TSCI = f(Rail & Joints, Ties, Ballast & Subgrade)

- Index for each component group.
  - RJCI - Rail & Joints Condition Index
  - TCI - Tie Condition Index
  - BSCI - Ballast & Subgrade Condition Index
- Compile component group indexes into an overall TSCI.

RJCI, TCI, BSCI…

A mathematical calculation for quantifying the mean subjective rating of a group of railroad track experts with many years of experience.

- 28 Experts
- 22.5 years of experience (average)
- Over 13,000 data points

Weighted Deduct-Density Model

Degree of deterioration is a function of:

- Types of Distress
- Severity of Distress
- Amount (Density) of Distress

Model Mathematics

$$CI = C - \sum_{i=1}^{P} \sum_{j=1}^{m_i} a(T_i, S_j, D_{ij}) F(t,d)$$

where CI = RJCI, TCI, or BSCI

C = 100

a( ) = Deduct Weighting Value for Given Distress Type (T_i), Severity Level (S_j), and Density (D_{ij})

i = Counter for Distress Types

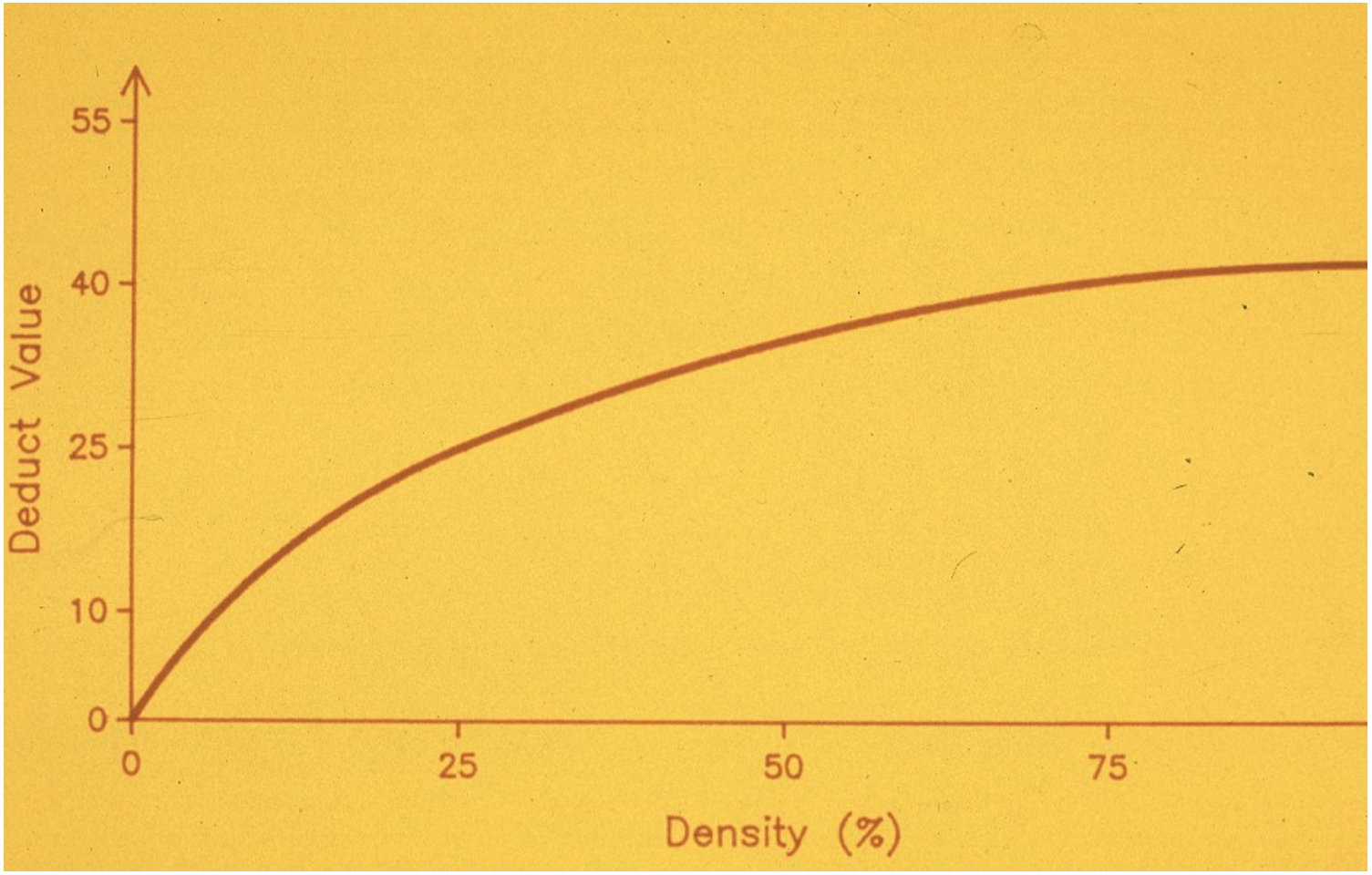
j = Counter for Severity Levels

p = Total Number of Distress Types

m_i = Number of Severity Levels for ith Distress Type

F(t,d) = Adjustment Factor Based on Total Deduct Values (t) and Number of Deducts (d)

Deduct Curve Concept



Severity Level Descriptions

- Low (L) Minor distresses that do not affect train operations. Routine M&R can be scheduled for accomplishment.
- Medium (M) Distresses that may or may not cause an operating restriction on the track. M&R should be scheduled for accomplishment.
- High (H) Distresses that generally would cause an operating restriction on the track. M&R must be accomplished to remove the restriction.
- Very High (VH) Distresses that prevent train operations or place a very severe operating restriction on the track. M&R must be accomplished to restore train operations.

RJCI Distress Types

- R1 - Rail Defects
- R2 - Joint Defects
- R3 - Hold-Down Device Defects
- R4 - Tie Plate Defects
- R5 - Gauge Rod Defects
- R6 - Rail Anchor Defects

R1 Defect Examples

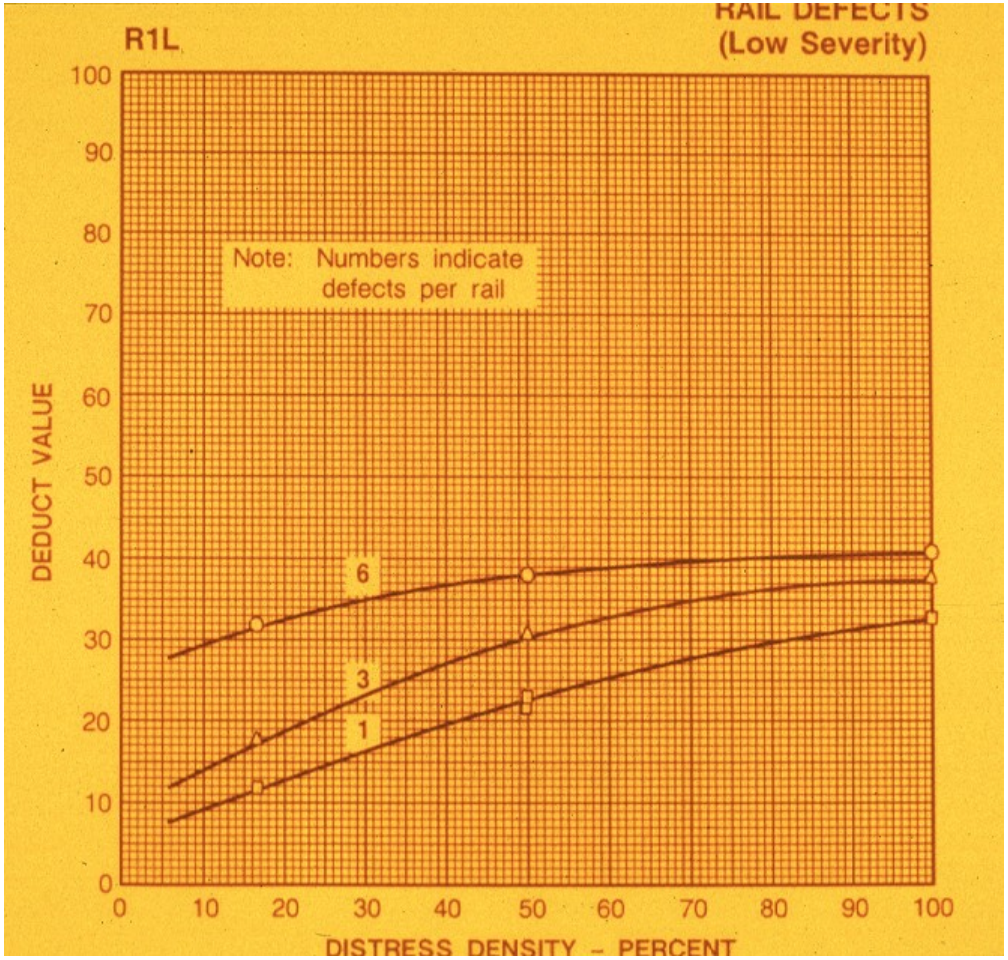
- Low (L) Flaking, Overflow, Slivers, etc.
- Medium (M) Bolt Hole Crack < 0.5”, Torch Cut Rail, End Batter > 0.25”, etc.
- High (H) Bolt Hole Crack > 0.25” and < 1.5”, Torch Cut Hole, Vertical Split Head > 2.0” and < 4.0”, etc.
- Very High (VH) Bolt Hole Crack > 1.5” or breakout, Complete Break, Head Web Separation > 3.0” or breakout, etc.

- Measurement: Each rail. Count the number of times a defect occurs in rail, except for low.

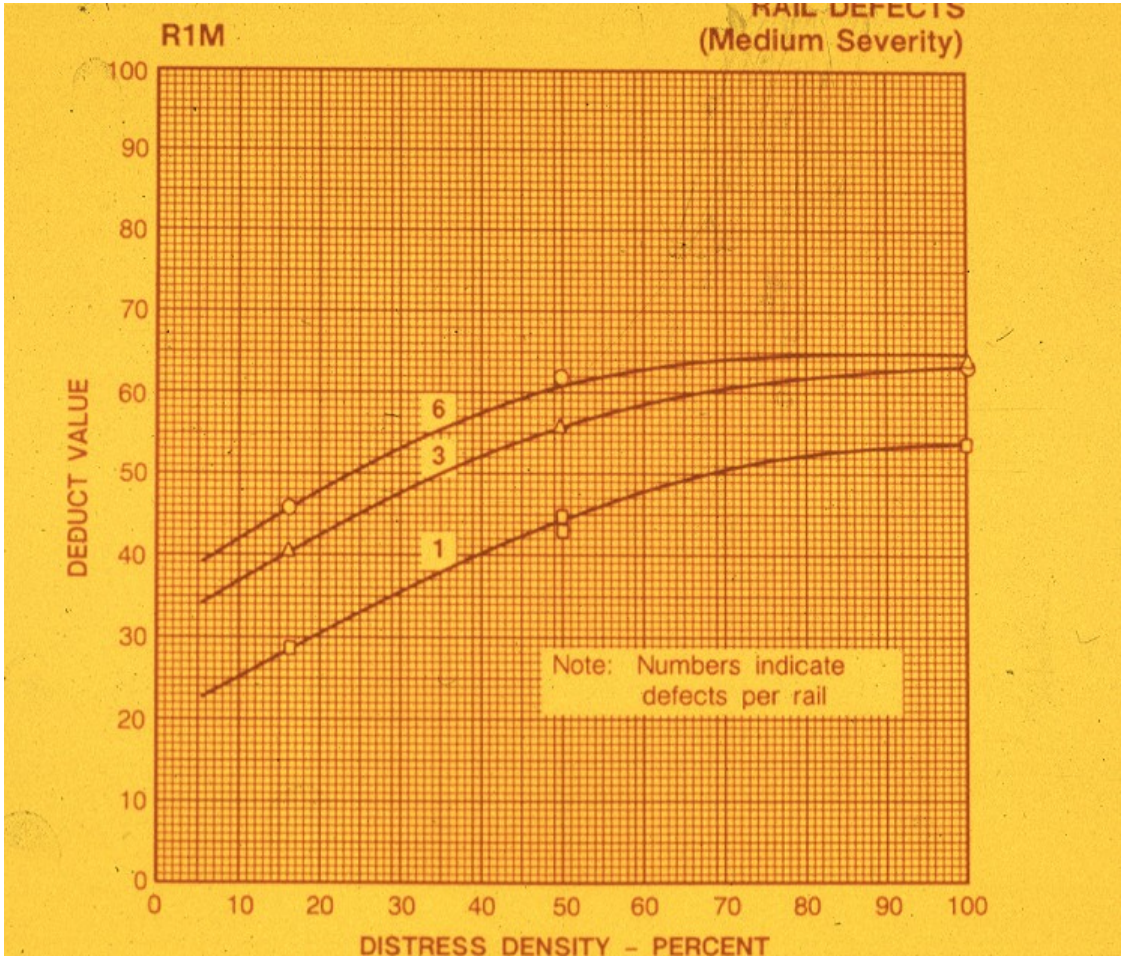
- Density = $\frac{\text{\# of affected rails with given \# of defects}}{\text{Total \# of rails}}$

Example R1-VH Defect

R1-L Deduct Curves



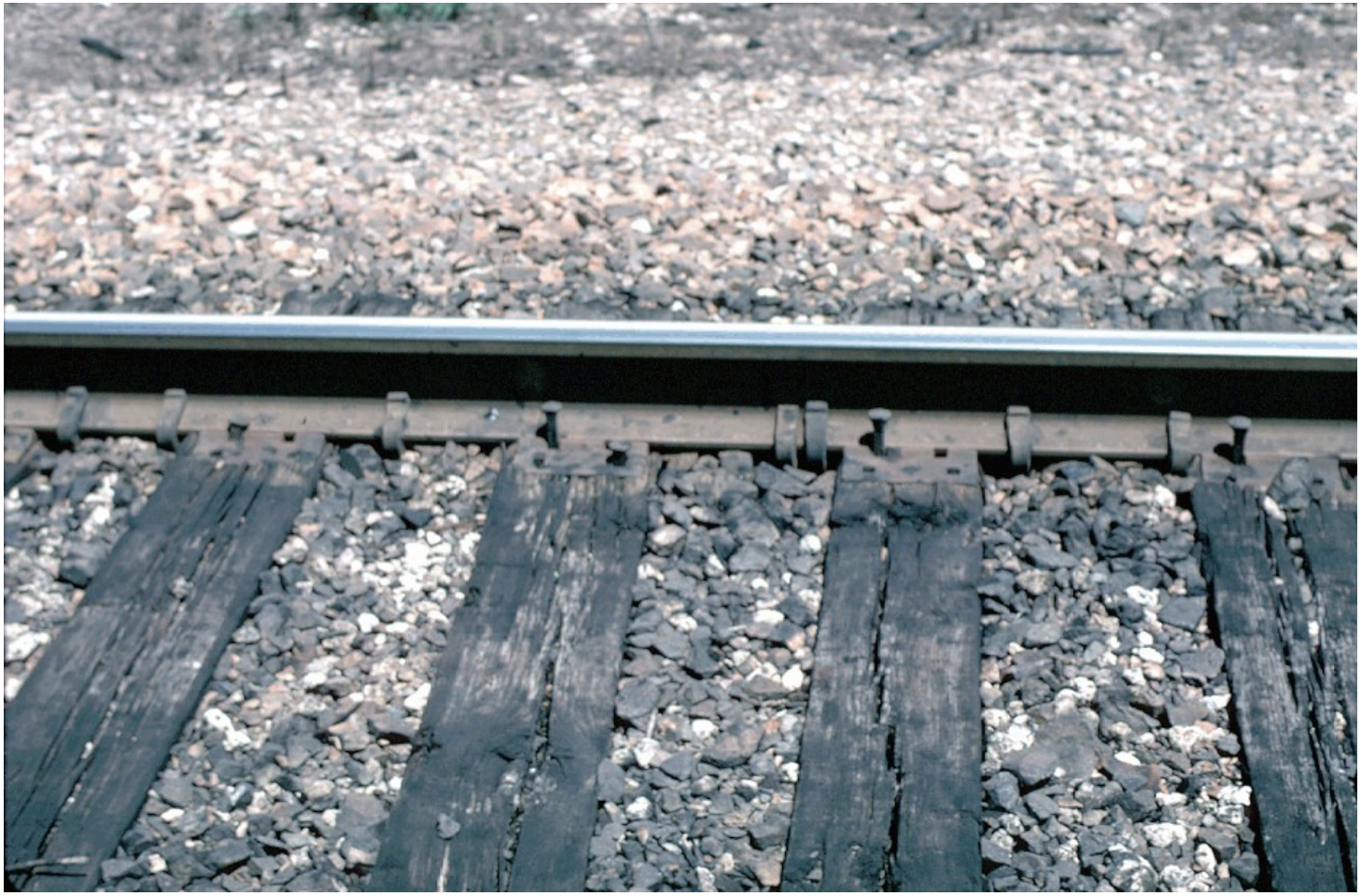
R1-M Deduct Curves



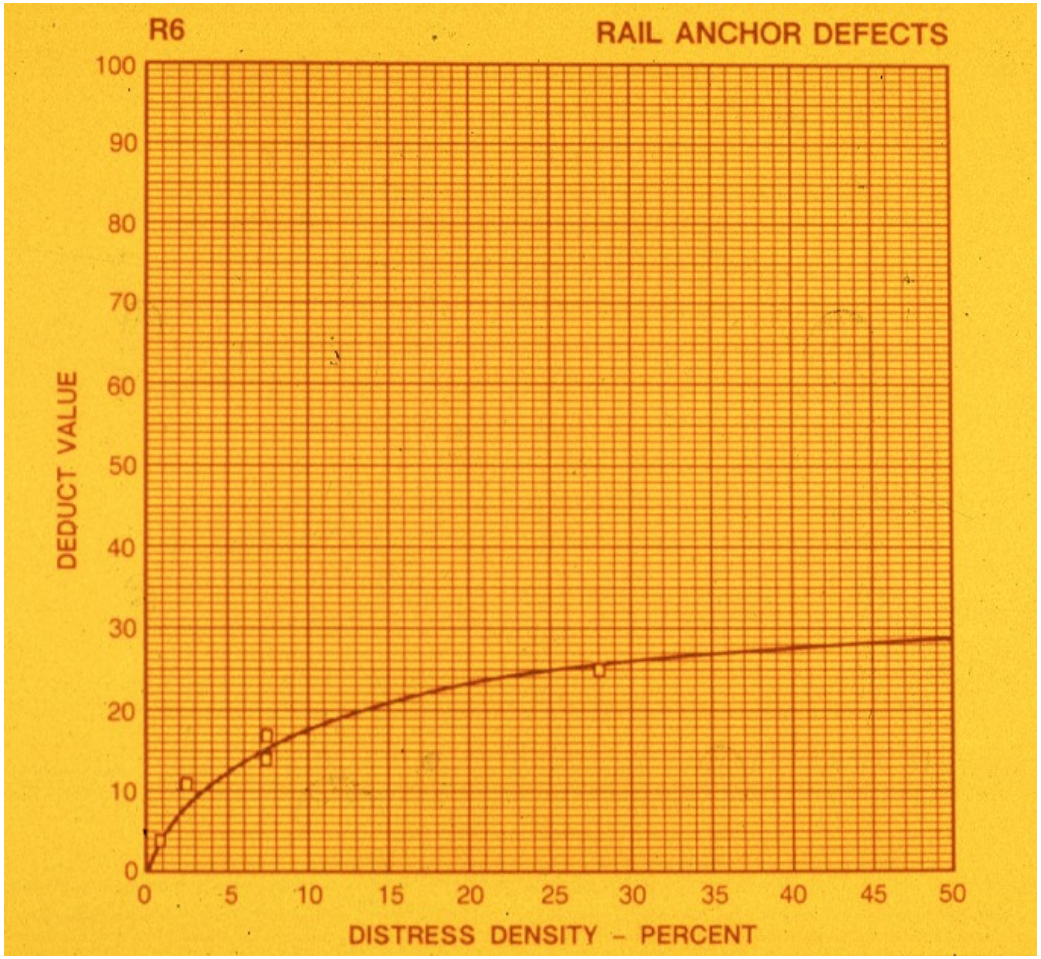
R6 Defects

- Severity Levels: N/A
- Defects: Improperly positioned, loose, or missing
- Measurement: Each anchor
- Density = # of defective anchors / Total # of ties x 4

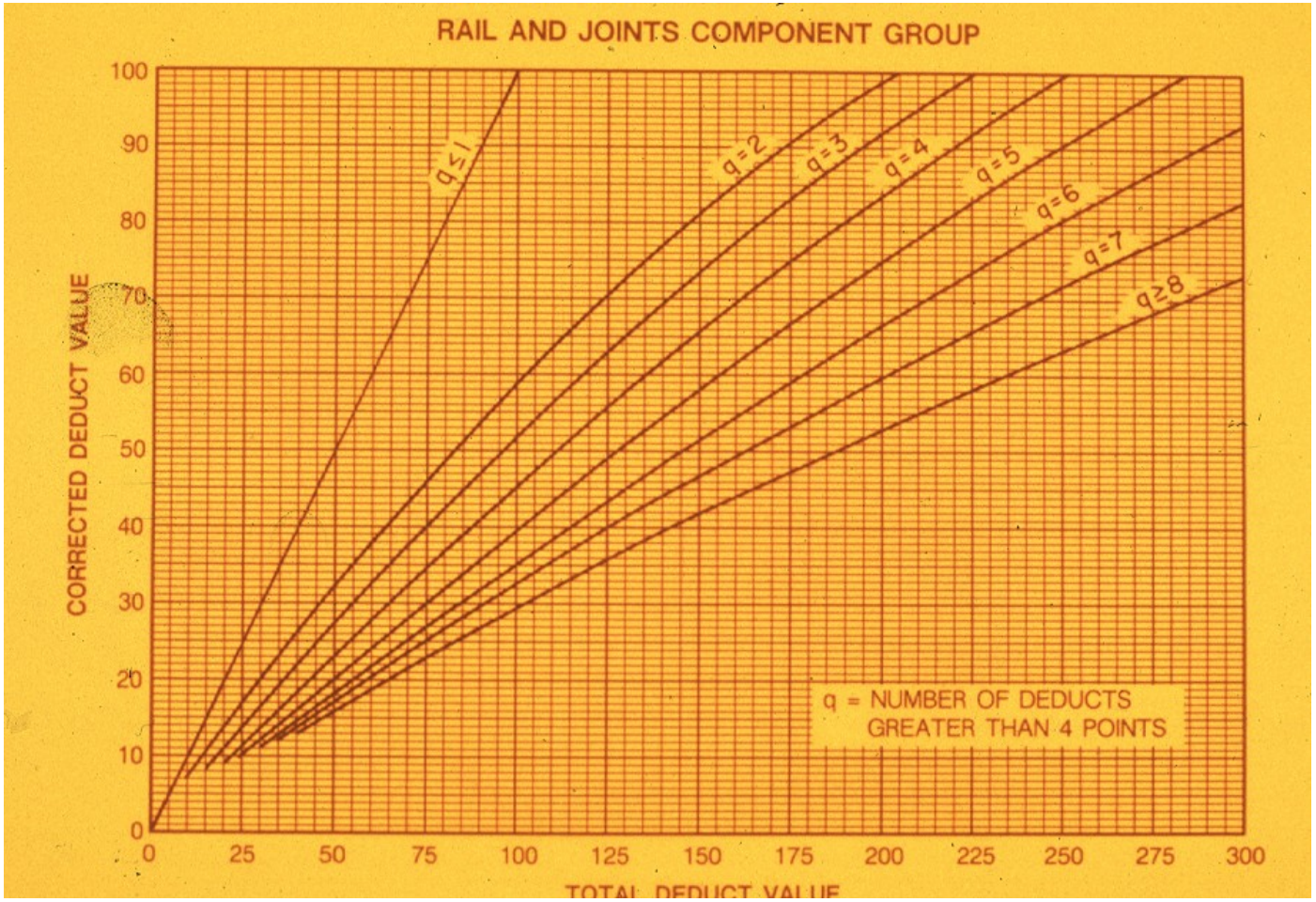
Example R6 Defect



R6 Deduct Curve



RJCI Correction Curves



TCI Distress Types

- T1 - Single Defective Tie
- T2 - Isolated Defective Tie Cluster
- T3 - Isolated Defective Tie Cluster that Includes One Joint Tie
- T4 - Adjacent Defective Tie Cluster
- T5 - Joint Tie Cluster
- T6 - Missing Tie
- T7 - All Joint Ties Missing
- T8 - Improperly Positioned Tie

T2 Defects

- Low (L) Two-in-a-row
- Medium (M) Three-in-a-row
- High (H) Four-in-a-row
- Very High (VH) Five-in-a-row

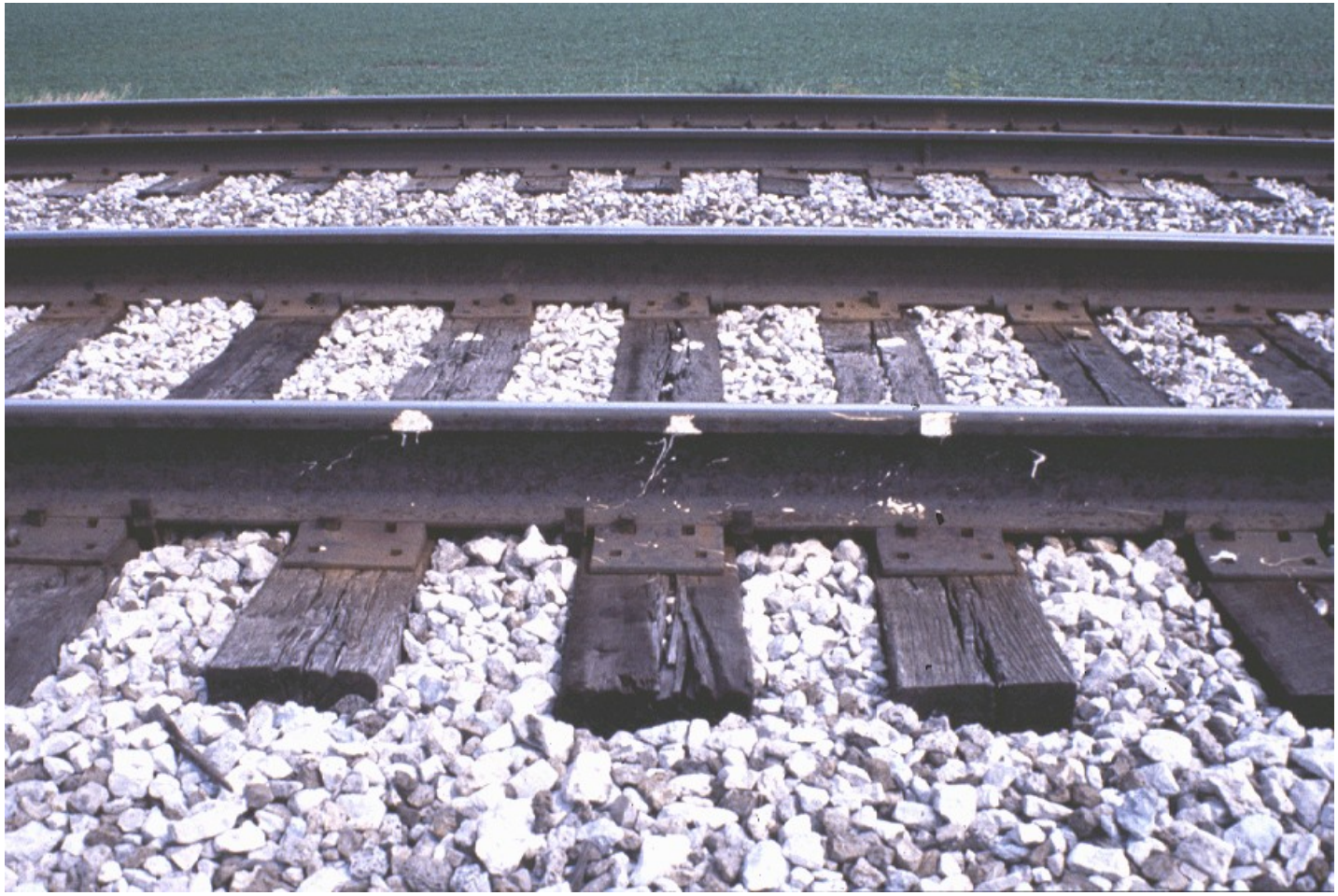
Measurement: Each occurrence.

Density = Each occur x # Ties @ SL / Total Tie #

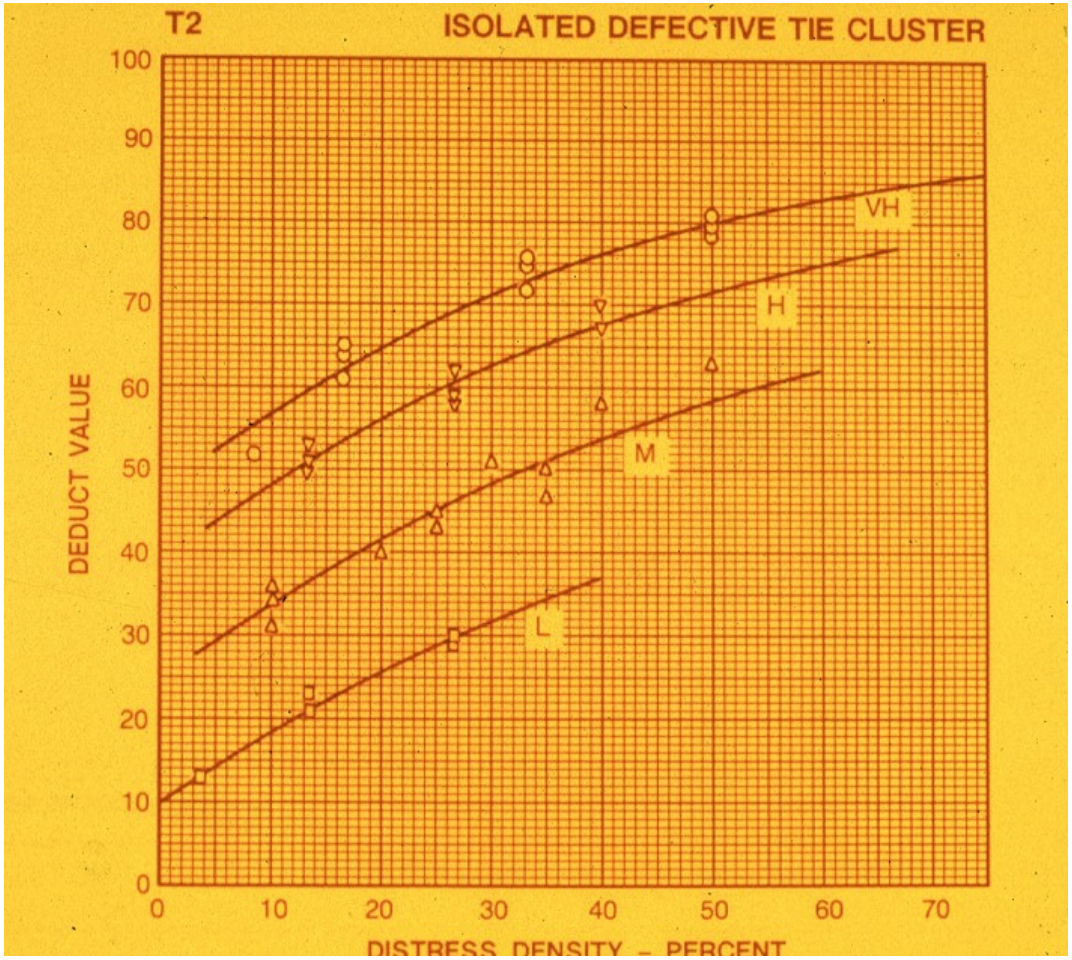
Notes:

- 1) A cluster is isolated if two or more good ties separate clusters.
- 2) If more than five ties in a row are defective, distress T4 pertains and divide into groups of five, plus what's left.

Example T2-M Defect



T2 Deduct Curves



BSCI Distress Types

- B1 - Dirty (Fouled) Ballast
- B2 - Vegetation Growth
- B3 - Settlement of Ballast and/or Subgrade
- B4 - Hanging Ties at Bridge Approach
- B5 - Center Bound Track
- B6 - Pumping Ties
- B7 - Alignment Deviation
- B8 - Insufficient Crib/Shoulder Ballast
- B9 - Erosion of Ballast
- B10 - Inadequate Trackside Drainage
- B11 - Inadequate Flow through Drainage Structures

B2 Defects

- Low (L) Vegetation present
- Medium (M) Interferes with inspection
- High (H) Interferes with train ops
- Very High (VH) Prevents train ops

Measurement: Linear feet of affected track.

Density = Affected track length / Total track length

Example B2-M Defect

B3 Defects

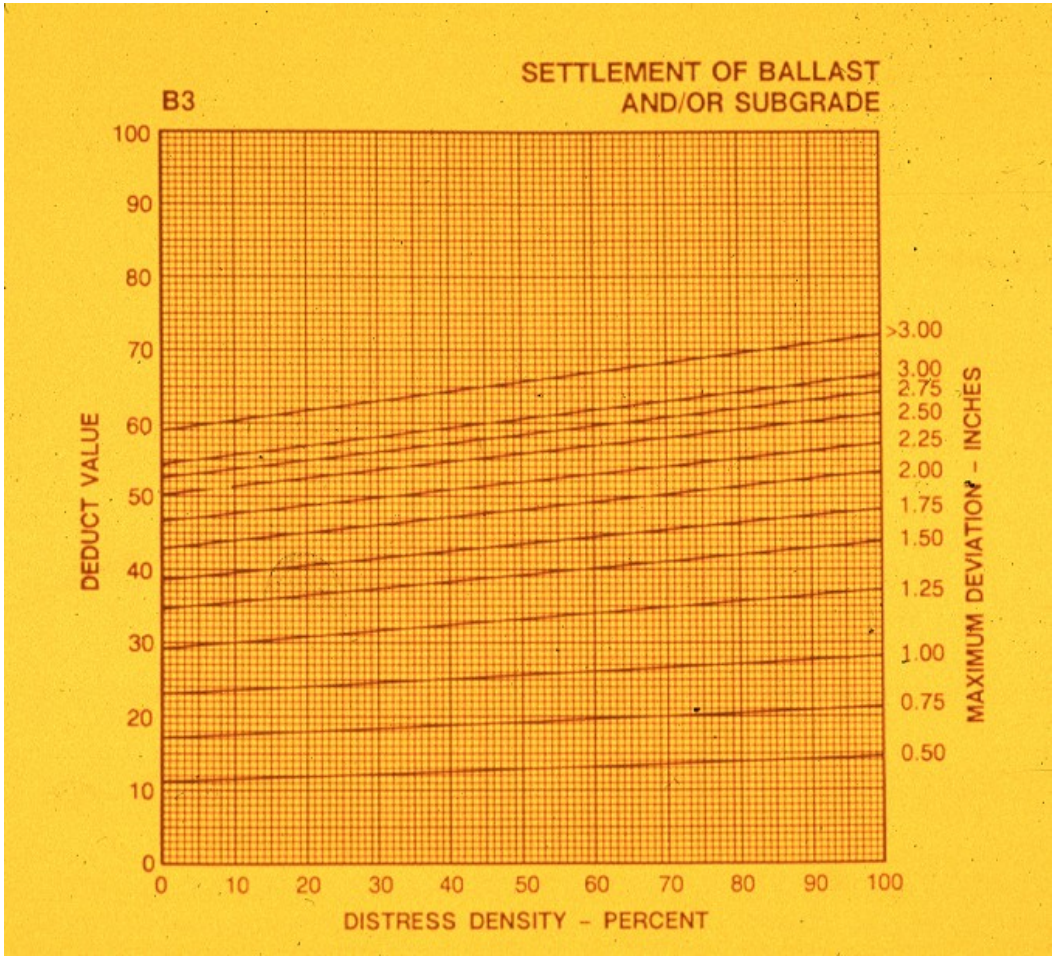
- Low (L) Profile: >0.75” and <2.25” Crosslevel: >0.50” and <1.50” Warp: >0.50” and <1.75”
- Medium (M) Profile: >2.25” and <2.75” Crosslevel: >1.50” and <2.25” Warp: >1.75” and <2.25”
- High (H) Profile: >2.75” and <3.00 Crosslevel: >2.25” and <3.00” Warp: >2.25” and <3.00”
- Very High (VH) Profile, Crosslevel, and Warp: >3.00”

Measurement: Linear feet of affected track.

Density = Affected track length / Total track length

Example B3-M Defect

B3 Deduct Curves



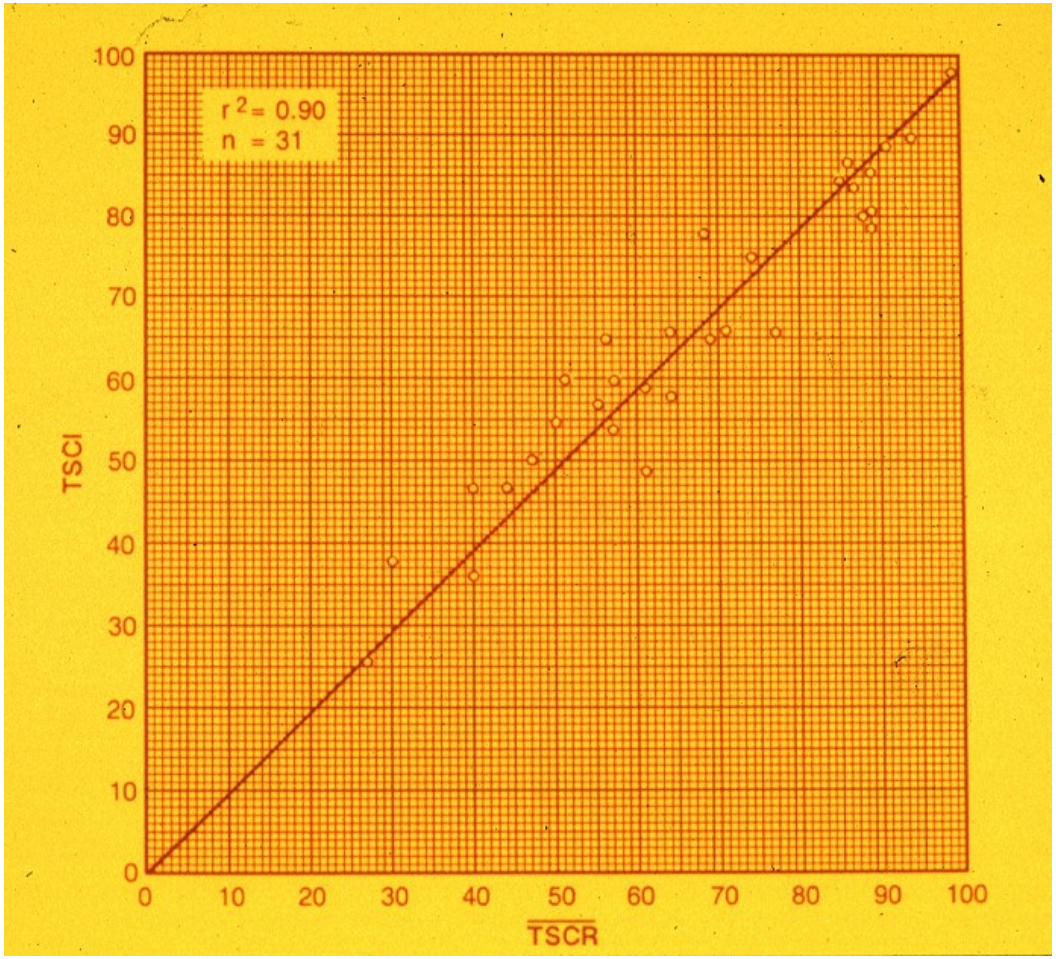
TSCI Equation

TSCI = 0.50(Lowest) +
0.35(Middle) +
0.15(Highest)

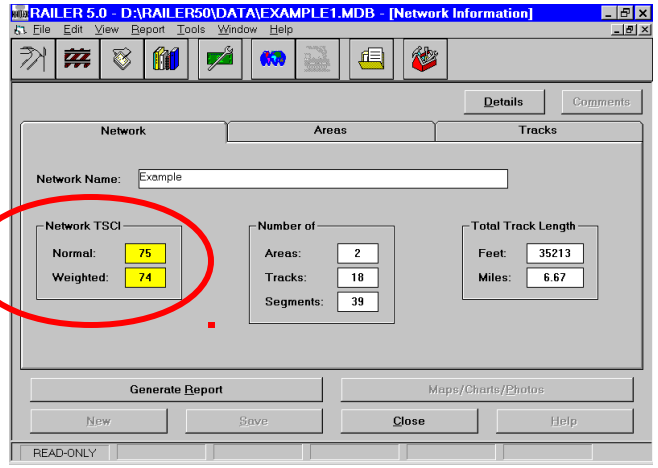
"Lowest" is the lowest numeric value of the RJCI, TCI, and BSCI. Likewise for "Middle" and "Highest."

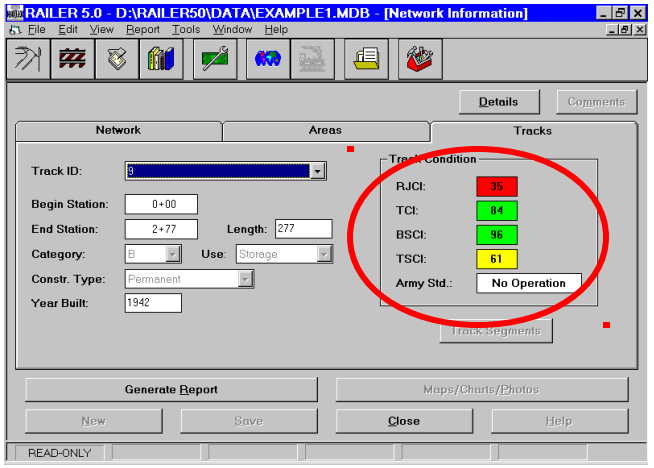
Derived from regression analysis

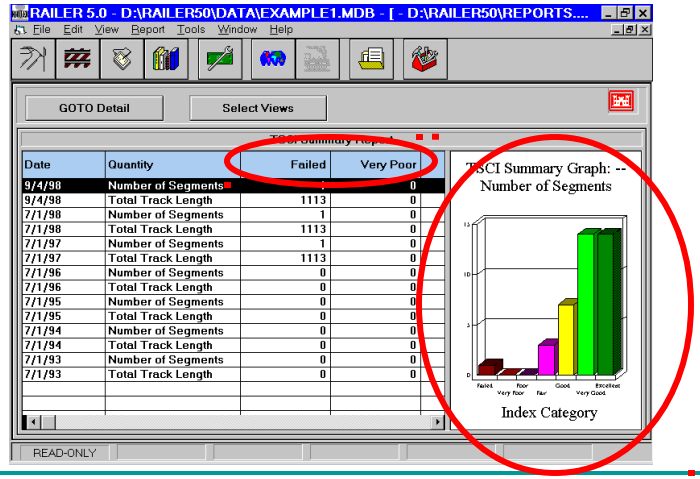
TSCI Correlation



Indexes Viewed in RAILER



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GOTO Detail
Select Views
Date
Quantity
Failed
Very Poor
9/4/98 Number of Segments 1 0
9/4/98 Total Track Length 1113 0
7/1/98 Number of Segments 1 0
7/1/98 Total Track Length 1113 0
7/1/97 Number of Segments 1 0
7/1/97 Total Track Length 1113 0
7/1/96 Number of Segments 0 0
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7/1/94 Number of Segments 0 0
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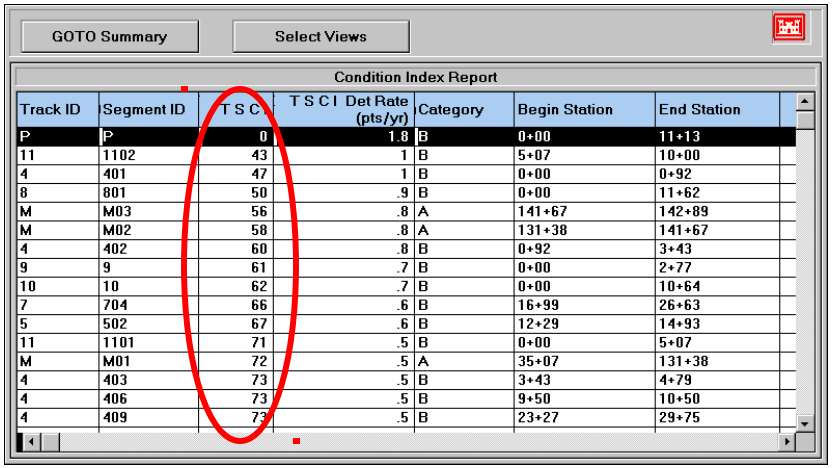
TSCI Summary Graph: -- Number of Segments
Index Category
READ-ONLY



Summary

- The TSCI measures track condition and deterioration rates based on routine visual track inspections.
- The TSCI is a function of the RJCI, TCI, and BSCI.
- The TSCI reflects the ability of a track to support routine expected traffic and loads.
- The TSCI reflects the subjective numerical ratings of a group of track experts.